The Challenge to Resilience

The threat from natural disasters and climate change

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Magnitude ≠ What You Feel

January 9, 1857 Fort Tejon M7.8

January 17, 1994 Northridge M6.7

Northridge
Rate of intense earthquake shaking

Level of Earthquake Hazard

These regions are near major, active faults and will on average experience stronger earthquake shaking more frequently. This intense shaking can damage even strong, modern buildings.

These regions are distant from known, active faults and will experience lower levels of shaking less frequently. In most earthquakes, only weaker, masonry buildings would be damaged. However, very infrequent earthquakes could still cause strong shaking here.

Map credits:
- Color bands and map projection: Esri
- County boundaries: US Census Bureau
- Roads:
  - National Highway System:
    - U.S. Federal Highway Administration
  - California: Caltrans
- Water:
  - National Hydrography Dataset:
    - U.S. Geological Survey
  - California: California Department of Water Resources
- Reference basemap data:
  - U.S. Census Bureau"
CO$_2$ over 5,000 centuries

Source: NASA
Global average temperature

Global Average Temperature 1850 - 2017

Land data prepared by Berkeley Earth and combined with ocean data adapted from the UK Hadley Centre

Global temperature anomalies relative to 1951-1980 average

Vertical lines indicate 95% confidence intervals

Source: Berkeley Earth
Put them together...
Implications for Los Angeles of climate change

- Increase in extreme heat days
  - Hottest day of the year increase by up to 10°F

Source: California’s Fourth Climate Change Assessment, Lead Author: Alex Hall, UCLA
Hottest day of the year

Two models show increase in hottest days of 5° to 9°

Historical 1976-2005

CO₂ peaks in 2040
RCP4.5 2070-2100

CO₂ rises through 21st century
RCP8.5 2070-2100

Average hottest day of the year (°F)

RCP4.5 - Historical

RCP8.5 - Historical

Change in hottest day of the year (°F)
Implications for Los Angeles of climate change

• Increase in extreme heat days
  • Hottest day of the year increase by up to 10°F
• Increase in intensity of storms
  • Wettest day of the year +30%

Source: California’s Fourth Climate Change Assessment, Lead Author: Alex Hall, UCLA
Wettest Day of the Year

CO$_2$ peaks in 2040

CO$_2$ rises through 21$^{st}$ century

Historical 1976-2005

RCP4.5 2070-2100

RCP8.5 2070-2100

Average wettest day of the year (inches)

Change in wettest day of the year (%)
Implications for Los Angeles of climate change

- Increase in extreme heat days
  - Hottest day of the year increase by up to 10°F
- Increase in intensity of storms
  - Wettest day of the year +30%
- Increase in intensity of droughts
- Sea level rise of a few feet
  - Increased coastal erosion in storms
- Increased wildfires by uncertain amount

Source: California’s Fourth Climate Change Assessment, Lead Author: Alex Hall, UCLA
A System of Systems
Critical Infrastructure

- Electricity
- Water
- Gas
- Buildings
- Internet
- Cell Towers
- Phone Systems
Necessary Systems
What does this mean for resilience?

• How do we handle the increase in common problems?
  • Increased heat,
  • Increased intense storms,
  • Increased wildfires

• How do we handle the extreme events?
What does the change in common problems mean for resilience?

- Increased heat,
- Increased intense storms,
- Increased wildfires
- Access to affordable housing is a matter of life and death
What do the extreme events mean for resilience?

- We cannot assume that normal is all we deal with
ShakeOut Estimates

- 255,000 displaced households
- 300,000 buildings damaged beyond 10% of their value
- 1,500 collapsed buildings
In California earthquakes, for each collapse, we average:

- 13 red-tagged buildings
- 50 yellow-tagged buildings

HayWired predicts 1/4 of Bay Area modern code buildings will be impaired
Christchurch
Feb. 22, 2011
M6.3
Most people don’t know what the code provides

- What is the building code’s objective?

Survey of 814 people by Dr. Keith Porter, U. Colorado:
Moving to a Functional Recovery Standard

• AB 1857: Establish a working group to develop a “Functional Recovery” building standard within 3 years and provide recommendation for where it should be mandatory.
All outside water crosses the San Andreas fault to reach Los Angeles.
HayWired Water Restoration

- Six months to restore complete water service
- Brittle pipe replacement program could cut the down time in half